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Abstract. In this paper, we propose resource allocation optimization problems for indoor Optical Wireless Communications uplink. More precisely, a Binary NP-HARD optimization problem together with its relaxation are proposed. Cuckoo Search (CS) and Genetic Algorithms (GA) have been unlikely to find feasible solutions when dealing with the relaxation of the problem. For the binary model, Binary Cuckoo Search outperforms the classical GA achieving better solutions in less computational CPU time.

Keywords: Pervasive computing · Optical wireless communications · NP-hard

1 Problem Formulation and Methods

Ubiquitous Computing collects information from a variety of sources in any location and in any time. Due to the recent advances in wireless communications, integrated digital circuits, micro electro mechanical systems and the mobile technology many devices are now connected through a wireless link. In the recent years, Optical Wireless Communication (OWC) has been subject of study of many researchers. OWC provides many advantages compared to Radio Frequency (RF) making this technology suitable for new generation devices.

The proposed optimization problems referred to as OPT1 and OPT2 are defined next. OPT1 tries to increase the speed of the transmitting information by assigning each device in a pre-defined partition of the channel while OPT2 intends to maximize the bit rate of the wireless link by defining the percentage of the sub channel that will be assigned to each device. The channel link is modeled by the fundamental equations formulated in Komine & Nakagawa [1]. We use Cuckoo Search, Binary Cuckoo Search [2] and Genetic Algorithms [3].

The mathematical model can be formally written as:

$$\max_{\{x_{u,c},P_{u,c}\}} \sum_{u=1}^{U} R_u = \sum_{u=1}^{U} x_{u,c}(\mathrm{B/C})\log_2\Big(1 + \frac{R_{PD}H_{u,c}P_{u,c}}{\sum\limits_{\substack{j\neq u\\ j=1}}^{U}\sum\limits_{\substack{k\neq c\\ k=1}}^{C} x_{j,k}H_{j,k}P^{*}_{j,k} + \sigma}\Big). \tag{1}$$

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The optimization problem is subject to different limitations. In OPT1 $x_{u,c} \in \{0,1\}$ while in OPT2 $0 \le x_{u,c} \le 1$. For both $P_{u,c} \in \mathbb{R}$, $0 \le P_{u,c} \le 10$

$$\sum_{u=1}^{U} x_{u,c} - 1 \le 0 \; \forall \, c \in C, \; 1 - \sum_{c=1}^{C} x_{u,c} \le 0, \; \sum_{c=1}^{C} x_{u,c} P_{u,c} - 10 \le 0 \; \forall \, u \in U. \quad (2)$$

2 Results and Conclusion

It can be seen from Table 1 that the BCS algorithm is faster to compute feasible solutions. GA overcomes BCS in 4 scenarios. Nevertheless GA also provides unfeasible (Unf) solutions in scenarios where BCS provides a feasible one.

Table 1. Objective function values for OPT1 and OPT2 by using BCS, CS and GA

Devices	Channels	R_{OPT1} BCS	R_{OPT2} CS	R_{OPT1} GA	R_{OPT2} GA	BCS Fitness GAP (%)	GA Time Gap (%)
4	32	180.74	Unf	154.15	Unf	17.24	−32.05
8	32	70.45	Unf	79.19	Unf	−11.03	−37.84
12	32	451.54	Unf	518.17	Unf	−12.85	−42.22
14	32	269.03	Unf	Unf	Unf	–	–
4	64	20.54	Unf	29.46	Unf	−30.26	−35.39
8	64	205.49	Unf	Unf	Unf	–	–
12	64	166.77	Unf	Unf	Unf	–	–
14	64	53.14	Unf	Unf	Unf	–	–
	Min	70.45	–	62.70	–	–	–
	Max	668.59	–	732.14	–	–	–
	Average	233.68	–	155.81	–	–	–

In this case, BCS outperforms GA reaching feasible solutions in less computational time. The relaxation proposed cannot find feasible solutions in the searching space. In a future work a decomposition approach will be proposed in order to deal with the binary NP-HARD optimization problem.

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